AD694648

DIGITAL COMPUTER NEWSLETTER

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

Vol. 18, No. 2 April 1968

Gordon D. Goldstein, Editor
Margo A. Sass, Associate Editor
Yvonne H. Kilgore, Editorial Assistant
Elaine K. Strohl, Editorial Assistant

CONTENTS

Approved by
The Under Secretary of the Navy
25 September 1961

NAVSO P-645

Reproduced by the
CLEARINGHOUSE
for Federal Scientific & Technical
Information Springfield Va. 22151

This document has been approved for public release and sale; its distribution is unlimited.

DDC
OCT 16 1969
B

35

Editorial Policy Notices

EDITORIAL

The Digital Computer Newsletter, although a Department of the Navy publication, is not restricted to the publication of Navy-originated material. The Office of Naval Research welcomes contributions to the Newsletter from any source. The Newsletter is subject to certain limitations in size which prevent publishing all the material received. However, items which are not printed are kept on file and are made available to interested personnel within the Government.

DCN is published quarterly (January, April, July, and October). Material for specific issues must be received by the editor at least three months in advance.

It is to be noted that the publication of information pertaining to commercial products does not, in any way, imply Navy approval of those products, nor does it mean that Navy vouches for the accuracy of the statements made by the various contributors. The information contained herein is to be considered only as being representative of the state-of-the-art and not as the sole product or technique available.

CONTRIBUTIONS

The Office of Naval Research welcomes contributions to the Newsletter from any source. Your contributions will provide assistance in improving the contents of the publication, thereby making it an even better medium for the exchange of information between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in transmitting technical material and suggestions to the editor for future issues. Material for specific issues must be received by the editor at least three months in advance. It is often impossible for the editor, because of limited time and personnel, to acknowledge individually all material received.

CIRCULATION

The Newsletter is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

For many years, in addition to the ONR initial distribution, the Newsletter was reprinted by the Association for Computing Machinery as a supplement to their Journal and, more recently, as a supplement to their Communications. The Association decided that their Communications could better serve its members by concentrating on ACM editorial material. Accordingly, effective with the combined January-April 1961 issue, the Newsletter became available only by direct distribution from the Office of Naval Research.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

GORDON D. GOLDSTEIN, Editor
Digital Computer Newsletter
Informations Systems Branch
Office of Naval Research
Washington, D.C. 20360

3300/3500 Time Sharing Systems

Control Data Corporation
Minneapolis, Minnesota 55440

George S. Hanson, Vice President of Marketing for Control Data Corporation anncunced in November 1965 the availability of two new computer systems, the Control Data (R) 3300 and 3500, which offer a unique approach to time-sharing a computer.

The two systems combined extremely fast processing speeds with a new concept for computer memory storage to process a large number and a wide variety of problems on an "immediate access" basis.

"In this way," Hanson explained, "Each user views the computer as if it were his exclusively, even though a great many users may be sharing the same system at the same time. There will be no waiting in line to use a 3300 or 3500."

"To accomplish this," Hanson continued, "Both systems must be extremely fast. Both are. Under operational conditions, they are up to 80 percent faster than major competitive systems in the same price range. The 3300 has a cycle time of 1.25 microseconds, and the 3500, which features Control Data's newly-designed INTEBRID (TM) circuit, has a cycle time of 0.80 microsecond."

To make maximum use of these speeds, magnetic core memory storage for both systems has been partitioned into 2000-word "pages." Each page is further divided into four sections. This provides a highly efficient method of accommodating a wide variety of programs, regardless of their size or complexity. Programs are broken down into page segments, with quarter-page locations available for any part of any program that does not fit into a full-page. This includes small programs and subroutines.

"One of the outstanding features of the entire operation," Hanson emphasized, "is that the user need not be aware that all of this is taking place. A monitor or software technique (information traffic director) establishes program priorities, and, when necessary, transfers low priority programs to temporary storage devices. The user need only be aware of the particular piece of equipment he is using at the time."

An extensive variety of peripheral and computer input-output equipment is available for use with both the 3300 and 3500, including Control Data's newest optical display and data collection devices.

These systems are highly adaptable to all processing assignments: Business, industrial or scientific. "Furthermore," Hanson said, "they are particularly suitable for use in a 'total information management' type of operation."

"For the first time," Hanson pointed out, "Multi-divisional organizations, such as the large university, business and industrial firm, as well as government agencies can take advantage of sharp reductions in operating costs, through a more efficient management of computer facilities, especially when a 3300 or 3500 is doing the managing; on an automatic basis."

PRIORITY PROGRAMMING

Program priority, being dynamic, can change in time. The computer gives full computing attention to the top priority program until its priority status is changed by completion, time interruptions, manual intervention, I/O call, or subroutine call. In batch processing, there are the obvious delays based on length of program and speed of the system. In a multi-access system, the top priority program normally changes more often on the basis of an assigned running time.

In the 3300/3500 systems, batch processing and multi-access jobs can be intermixed. The computer still gives its fullest computing attention to the program of top priority while

concurrently handling I/O for several other jobs. This is possible through a technique of dynamic relocation of programs, dynamic allocation of storage and dynamic control of priority.

PROGRAM RELOCATION

The high-speed central processor not only handles computation but reserves a small part of its capability for "housekeeping." Housekeeping tasks are extremely important to the time-sharer to:

- identify the active programs, and determine the top priority program to be executed;
- process program requests – subroutines required, I/O required, and so on – for the active program;
- maintain program lists;
- process normal requests – interrupts after I/O, console interrupts, interrupts on a time basis for multi-access, and so forth;
- set program transfers;
- control program protection;
- process abnormal conditions – error conditions in I/O, storage, arithmetic, and the like.

The 3300/3500 time-sharing systems, then, can be described as very high-speed computer systems and fully implemented time-sharing systems with rapid program relocation, positive and complete program protection, and fast program transfer.

The following chart shows how all programs, intermixed (relocation, program protection, and program transfer. . . in that order) operate at optimum speed and efficiency in a 3300 or 3500 system.

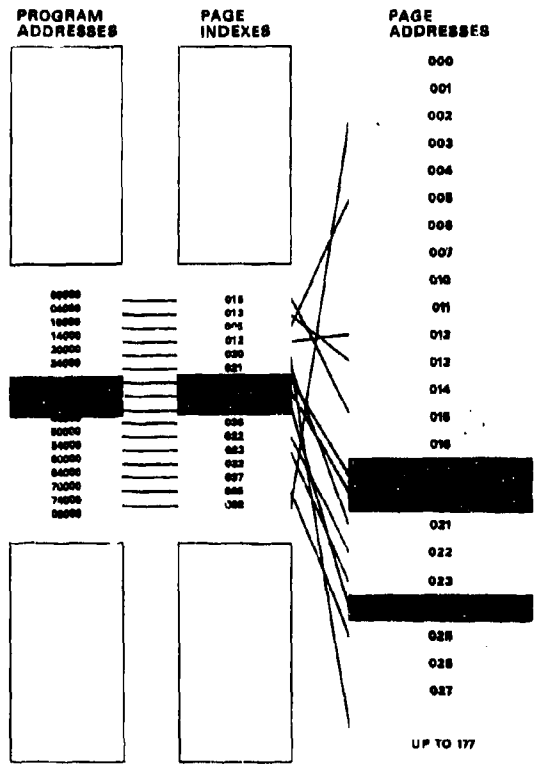
Memory is divided into 2048 word pages, then segmented in 512-word quarter-pages. This "deep" paging organization allows full relocation of a user's logically contiguous program in a non-contiguous fashion throughout physical memory. If a partial page is required, the program can be relocated in sub-pages of either 512 words, 1024 words, or 1536 words.

The subdivided core storage is addressed through a relocation file. Beginning with the first address of a program and continuing through to the last, each word is brought into one of 16 registers serving as page indexes. By substituting the contents of the appropriate page index register for the upper portion of the incoming addresses, the entire program address block is redirected to a memory page in one operation.

Based on the program's structure, every program is relocated through page indices into a required number of pages of memory.

These indices are maintained in a page index file containing up to 128 registers. As many as eight discrete programs can operate through their own individual page index block (see chart). This multi-programming organization makes use of random pages in memory.

The Executive program (MASTER) protects against all memory assignment conflicts even when several programs share the same pages in memory.



Program relocation in the 3300/3500 showing one program relocated into non-contiguous pages of memory

TIME SHARING FLEXIBILITY

In the 3300/3500 time-sharing systems, one integrated operating system is designed to supply all needs at the discretion of the individual installation – MASTER, Multiple Access Shared Time Executive Routine.

MASTER efficiently handles batch processing assignments through I/O operations overlapped with central computing functions from either single or multiple jobs – in effect, running batch processing jobs through the system in parallel to optimize machine use. At the same time, MASTER provides for conversational mode computing from multiple consoles. Routines within MASTER provide for background peripheral processing, assignment of I/O equipment and assignment of files as each program requires.

Total system efficiency is optimized with extremely fast response time to individual users through dynamic memory and I/O assignment.

MASTER makes full use of the 3300/3500 relocation hardware with its absolute memory protection features, allowing central core memory to be loaded to the maximum with individual jobs and operating system tasks.

MASTER provides the individual installation with a flexible structure on which to assign normal jobs a priority classification. At the same time, emergency jobs are immediately attended by the job scheduler.

In addition to MASTER, a second operating system is available that provides for batch processing as well as time-sharing between batch jobs and background programs. This is REAL-TIME SCOPE.

The advantages here are:

- Loading of programs and stacked job processing may function at the same time;
- A real-time program can retain control until satisfied. Fast response required at intervals is handled by priority interrupt;
- Channel reservation for high priority includes priority for real-time interrupts when they occur;
- Time-shared programs allow I/O overlap; and
- I/O bound programs function efficiently as background jobs.

Operating under REAL-TIME SCOPE, MSIO (Mass Storage Input/Output System) allows full control of operations on disk, drum, and disk pack units as well as magnetic tape systems.

MSIO allocates and protects permanent files in storage, and provides for sequential, sequential with linkage, or random file processing. Working with internal program requests, MSIO can read and write file records, inform users as to their file status, search for specific records in a file, specify location of block and logical records, and process variable length and fixed length record blocks. Users may add, delete and replace logical records on mass storage devices. MSIO also provides a set of utility routines to load, reorder, and reallocate mass storage files.

The 3300/3500 systems provide an organized central bank of data for all system users. Data may be stored in multi-level storage, thereby providing the facility for automatically storing and retrieving all the data used within a computer system. Data is organized into program or data files for easy handling by all types of users, including those concerned with business data processing requirements.

These systems allow any user, local or remote, to enter data or programs directly into mass storage files and also to request job executions. A set of file-handling subroutines may be accessed and used by direct call rather than through a language processor.

EXECUTIVE MODE

In the CONTROL DATA 3300 and 3500 systems, multi-programming enables the instructions of all programs in the system to be executed in sequence. The relocation features of both systems return a very high throughput to each program, particularly in installations running a great many jobs.

Operating in the Executive Mode, the systems function in either of two states: Monitor or Program State.

Monitor is the initial operating state of a processor that has been master-cleared. An interrupt for any condition will also set the processor to this state.

A processor in Program State will continually execute all program instructions except:

1. HALT instruction.

2. Any of the I/O instructions.

3. An inter-register transfer instruction that attempts to alter control registers in the system.

In the Program State, any attempt to execute one of these instructions automatically generates an Executive Interrupt. Control of that program immediately returns to the Monitor State. The interrupt system, in other words, does not need an "enabling function" to recognize the interrupt at the moment it occurs. The Executive Interrupt recognizes it and immediately transfers control. The instruction causing the interrupt is not executed.

Normal interrupts occur regularly in a time-sharing system from any of a number of sources – program error, reading or writing out of bounds or uncontrolled writing in registers, remote console interrupts, real-time interrupts, and so on.

Some of these – specifically remote console and real-time – are classified emergency, demanding immediate attention.

Under "emergency," the 3300/3500 interrupts the system immediately. Such priorities as are involved are determined by the installation parameters. When the interrupt occurs from an external channel, only the crucial systems – the operating system, table manipulations, and so forth – will continue during the interrupt.

In the split-instant of interrupt handling, the Executive decides if the interrupt is top priority and acts accordingly. The program currently executing will only be shunted to mass storage if the emergency program requires some memory space. If it can fit in core, the current program remains in core location fully protected.

GE-645 Time Sharing System

General Electric
Phoenix, Arizona

In December 1965, General Electric Company announced its largest and latest computer system – the GE-645 designed specifically for large-scale time-sharing operations.

Time-sharing is the novel technique of allowing many people to use a computer's full power simultaneously. It promises to radically reduce costs of computing while boosting the usefulness of computers sharply.

Harrison Van Aken, general manager of G.E.'s Computer Department, stated that the prime value of the GE-645 lies in its ability to provide vast computer power in many forms to hundreds of people simultaneously at reasonable cost.

Although cost of a GE-645 runs high – more than $150,000 a month rental in some versions, according to Mr. Van Aken – it replaces so many individual computers and opens up so many more problems to computer solution that the cost of computing can be cut drastically.

"It brings the age of instant computing within the reach of most businessmen and researchers through the use of information utilities," Mr. Van Aken said.

Sharing time of a computer has for the most part been confined to experimental and educational projects, Mr. Van Aken pointed out.

"Computers such as the GE-645 redistribute computer wealth among most potential users," he said.

Mr. Van Aken confirmed that early prototypes of the giant new computer were ordered by Massachusetts Institute of Technology's Project MAC in August 1964, and by Bell Telephone Laboratories, Inc., soon after.

Project MAC (for Machine Aided Cognition) is an MIT research program sponsored by the Advanced Research Projects Agency under an Office of Naval Research contract.

Bell Telephone Laboratories, Inc., also ordered three dual-processor versions of the same system early this year. The systems are valued at more than $23 million.

Ohio State University's computation center subsequently ordered another GE-645 computer for educational time-sharing work.

The first GE-645 systems will be delivered to MIT's Project MAC and Bell Telephone Laboratories in 1966. First production models will be ready for delivery by mid-1967.

"Present customer demands for the system have pushed availability until early 1968," Mr. Van Aken stated.

Prices for the new computer vary widely because of the individualized configurations needed by customers. Some GE-645 systems will rent for almost $150,000 a month, according to Mr. Van Aken, and may sell for more than $7 million.

Prices for the system's different configurations, however, will be established and announced early next year, Mr. Van Aken said.

In some applications of GE-645, as many as 300 individual people may use the computer at the same time, according to General Electric officials. More than 1000 terminals may be plugged into such a system.

The computer can respond in a variety of ways to its users according to their needs. It will answer in "real-time" or in milliseconds. It will answer "conversationally" to question and answer problem-solving jobs in seconds. And it will answer in the more traditional computer fashion by running a complete program or processing tedious jobs in "batches" lasting minutes to hours.

Thus, one computer system can plot a missile trajectory in "real-time," solve a step-by-step engineering problem "conversationally," and run off a payroll accounting job all during the same period of time, G-E officials pointed out.

Moreover, the G-E time-sharing system will accommodate a variety of communications devices plugged into it operating at varying speeds: small-scale digital computers, teletypewriters, visual display devices, and analog computers.

Key to the enormous time-sharing capability of the GE-645 is a new operating program known as MULTICS (for Multiplex Information and Computing Service). It was developed from research by the Massachusetts Institute of Technology, Bell Telephone Laboratories, and the General Electric Company.

MULTICS draws upon the design and operating experience gained with CTSS (Compatible Time Sharing System) and MIT's Computation Center and Project MAC.

General Electric's implementation of the system on the GE-645 is known as MULTICS 645/I, details of which will be available early next year, G.E. officials stated. As a comprehensive general-purpose program, later refinements and versions of the programming system are expected, according to General Electric officials.

The GE-645 possesses several unique characteristics which set it apart from existing time-sharing computer systems. Primary among them is its method of managing its vast memory through the use of a segmentation and paging technique.

No computer can store in its core the enormous quantity of data which is required when operating in a large-scale time-sharing mode. More than 100 programs representing up to 1 million words may have to move in and out of the core of the computer at microsecond speeds.

General Electric's solution in the GE-645 has been to segment programs into manageable lengths for fast processing in the computers' core. The core in turn is divided into "pages" and symbolically addressed. As a result, programs can be allocated to non-adjacent sections of the computer's core. This arrangement means much more efficient use of the computer's memory, a speed up in the movement of programs, and a significant increase in the number of users sharing the time of the computer.

The main switching center of the GE-645 is a general input-output controller (GIOC). A device new to commercial computer design, it manages the variety of communications going in and out of the central computer from terminals nearby or hundreds of miles away. It allows the computer to work on jobs assigned it by any number of terminals.

A high performance drum for the GE-645 holds up to 4 million words, and is able to transfer 500,000 words per second in and out of the central processor. It possesses a logic structure which allows it to keep an automatic queue of the computer's requests for transfer of data.

Computing Centers

The Desk Calculator
Computation Center
Carnegie Institute of Technology
Pittsburgh, Pennsylvania

The DC (Desk Calculator) is an on-line, conversational routine for use on the Carnegie Tech G-21 Time Sharing System. Its function is to evaluate algebraic expressions typed at a remote teletype and to type back answers immediately. Hence, the DC can be used to do a simple arithmetic problem or to do a hand simulation of a complicated program in order to locate bugs.

To call the DC, initiate a run in the normal manner by typing in a job card calling for the system CALC. Then, on the next line, follow the usual $$ to indicate the end of the program. Note that no input is to be typed in at this time. Your program (really just the call for the system) will then wait in the queue to be run. When it runs, it will print out a message telling you to begin.

The DC operates in upper core, so it can continue to operate while other programs are being run on both central-processors in the normal manner in lower core. Since upper core may be in use by other programs, there may be times when the DC cannot be called; if this occurs, a message will be printed out suggesting that you try again some other time. The DC itself, however, can be used by a number of users at the same time.

The general method of operation is as follows: The user types in a line of one or more statements, followed by a carriage return. The DC evaluates these statements, prints out any values that were requested, and gives the user type-in. The user then types in another line of one or more statements, followed by a carriage return, and the cycle continues. This back-and-forth action (conversational mode) can continue as long as the user desires. If the user presses BREAK , the DC will zero the variable region, printing out a message to indicate that this was done. If BREAK is again pressed, operation will be terminated. (Variables may be zeroed many times, if statements are processed between pressings of the BREAK .) If the user does not type in a new line within a certain time after the last operation of the DC (approximately 7 minutes), the DC will assume that the user has gone away, and it will turn the TTY off.

A statement is similar in many respects to an ALGOL assignment statement; however, conditional expressions (if---then---else---) are not allowed. There are available for use 26 real variables, represented by the letters 'A' through 'Z.' The following arithmetic operations are available, with heirarchy as indicated:

Done first: ↓ Truncation
↑ Expoentiation
*/ Multiplication, Division
Done last: +- Addition, Subtraction

Operations of the same heirarchy are performed left to right. Parentheses may be used in the normal manner to change the order of operation.

Seven standard functions are available, and are used by following the function name (listed below) by the argument enclosed in parentheses; the argument may be any expression except an assignment statement and may include other functions. The functions are:

ABS	Absolute value
EXP	Exponential, i.e., e^x
LOG	Log to the base e
SQRT	Square root
SIN	Sine
COS	Cosine
ARTN	Arctangent

Constants may be typed in as integers, decimal numbers, or in scientific notation, i.e., ALGOL numbers. Two fundamental

constants are also available, π, typed as PI, and e, typed as EE.

A line of input consists of a series of statements separated by semicolons. A statement may be in one of the following forms:

<VARIABLE> ← <EXPRESSION><TERMINATER>

The variable is set to the value of the expression.

→<VARIABLE>←<EXPRESSION><TERMINATER>

The variable is set to the value of the expression and this value is printed out.

→<EXPRESSION> <TERMINATER>

The value of the expression is printed out; no variables are changed.

→<VARIABLE> <TERMINATER>

The value of the variable is printed out; no variables are changed. Note that → indicates that a value is to be printed out. A<TERMINATER> is either semicolon or carriage return.

Various errors such as illegal characters, improper constructions, and so on may occur in a statement. When this happens, an error message will be printed out. If arguments to a subroutine are impossible [i.e., SQRT(-4)], an error message will be given. An ↑ will appear with all error messages below the column in which the error occurred. Processing stops immediately on the first error. All statements previous to the one containing the error will have been evaluated, and any values requested printed out. The statement containing the error and the ones following it will not be evaluated.

The DC ignores all blanks and tabs (control characters). If CTRL-U is typed as last character, the line will not be processed.

ITERATION FACILITIES IN DESK CALCULATOR

There now exists some very crude iteration facilities in desk calculator. It is possible to return to the beginning of a line of input for a specified number of times or because of a given condition.

At the point where iteration is desired, use the subroutine LOOP (N), where N is any expression. N will be evaluated once and the line will be repeated from the beginning to the LOOP N times. Caution: the card will be looped over a total of N+1 times.

Three conditions can be tested for: negative, positive, or zero. The three subroutines IFOM (E) or IFOP (E) or IFOZ (E) are used where E is any expression. E will be evaluated each time that the subroutine is executed. If the condition is met, operation will be returned to the beginning of the line. If the condition is not met, operation will pass to the next instruction.

NOTE: Due to the time-sharing nature of the desk calculator, it cannot calculate for long periods of time. In order to implement iteration, the part of the line that is repeated over must contain a request to print out some variable. If nothing is printed, the error message TOO MUCH TIME will be printed and the operation will be terminated when it runs out of time (anywhere from two to five times through the loop).

If you find that you are in an infinite loop and wish to terminate it, press BREAK which will then give you type-in for the next line. Pressing break at this time does not zero the variables.

Real-Time Computer System

University of Kentucky
Lexington, Kentucky 40506

A computer system which may be described as "on-line" and "real-time," is now being implemented by the Computing Center and the Pathology Department of the Medical Center. The terminal used by the Medical Center's Pathology Department is connected to the Computing Center's IBM 7040 computer by telephone. Dr. W.B. Stewart, Chairman of the Pathology Department, has in the Medical Center an IBM 1050 teleprocessing terminal, very similar to an electric typewriter, and a small card reader, both of which are connected to a special telephone. Through the telephone an operator can dial the telephone connected to 7040 which will answer with a special high-pitched whistle.

Once the two telephones are connected Dr. Stewart's machine can transmit data read

from punched cards over the line to the 7040. While the 7040 is accepting data and creating a tape file it also continues to perform other routines such as running closed shop programs.

The data transmitted from the cards consist of patients' names, hospital numbers and results of readings of the many instruments used in laboratory analyses, as well as information on readings of various standards for the test. When the contents of the last card have reached the 7040 the computer executes a special program written by Dr. Stewart and his staff. This program calculates the results of each test, then sorts them by patients and writes a tape in the format necessary for preparation of the daily laboratory reports for the patients' charts.

Then the computer goes back to doing other work, at the same time transmitting the results back to the Pathology Department's 1050 where the reports are automatically typed for transmittal to the patient units.

The program also punches cards which will be used later to compile various weekly summaries of patient laboratory tests, and for various statistical reports and scientific investigations.

Since the computer phones go through the university switchboard like any other university phone, a faculty member dialing a wrong number may occasionally find himself connected to a computer.

Computing Center

Rensselaer Polytechnic Institute
Troy, New York 12181

Rensselaer Polytechnic Institute has become one of the first colleges in the nation to install one of IBM's new generation of computers, System 360.

"We envisage that this multi-purpose computer will be used for an ever-increasing range of operations from classroom and research work to administrative and accounting tasks," said Dr. Richard G. Folsom, Rensselaer president.

"Present plans also call for the installation of terminals that can tap the power of the computer from various points on the campus, a laboratory, for example, or the treasurer's office.

"Ultimately, a complete 'management information system' is planned; one that will permit this technological university to apply the benefits of electronic data processing to virtually all its computational and record-keeping operations."

The IBM System/360 Model 30 was installed in historic Amos Eaton Hall in September 1965. In late December, it was transformed into a more powerful Model 50, which provides 10 times the computational power of the original IBM 1410 installation.

The total cost of the computer system is in excess of $1 million. The National Science Foundation is making a grant of $350,000 toward its purchase. Amos Eaton Hall has been renovated into a Mathematics Center and Computing Laboratory at a cost of $500,000, with $142,000 coming from a National Science Foundation grant.

Dr. Jack Hollingsworth, supervisor of Rensselaer's computer facilities, said that the new system is expected to handle some 2500 problems a day at the outset. System 360, with its advanced circuitry and control programs, can accept inquires from several sources simultaneously, set priorities and answer instantly even while in the midst of a longer "batch" job, such as a payroll.

"The impact that this new computer system will have on Rensselaer stretches the imagination," said President Folsom. "Virtually every student, professor, and top administrator will work with the computer at some time or another."

Among the varied tasks that the computer will handle, now or later, are the following: homework assignments, scientific and engineering research, instruction in computer design, classroom instruction, library records, student registration, grade reporting, class scheduling, accounting, alumni records, and payroll.

Honeywell H-200 Installation

U.S. Navy Oakland Supply Center
Oakland, California

The U.S. Navy has installed a Honeywell 200 computer system at its Oakland, Cal. supply center to maintain fleet inventories of repair supplies.

Prime job for the system is the Navy's supply operations assistance program (SOAP), which Oakland processes for both Atlantic and Pacific fleets. SOAP records insure that ships' inventories of repair parts and other supplies are kept up to the level of readiness prescribed by fleet authorities.

According to Lieutenant Commander P.W. Cronk, director of the data processing department, ships turn in excess parts and order other parts during their regular overhauls in port. SOAP's job is to insure that each ship has the required spare parts to support installed equipment.

The Honeywell 200 is reported performing its jobs 5.5 times as fast as its predecessor computer and saving nearly $2,000 a month in data processing costs.

The Navy gets from the SOAP listing produced by the new system a SAVE (Shortages and Valuable Excesses) list to make sure one ship is not buying parts another ship has in excess. Gathered as a by-product of the SAVE and SOAP operations is a Ship's History and Inventory Record that keeps track of the entire operation to help the Navy better manage its fleet-wide budgeting and parts flow.

The Honeywell 200 has a 16,384-character main memory, four magnetic tape drives, a high-speed printer and a card reader/punch unit. It is being leased by the Navy for approximately $6,000 a month.

Computers and Centers. Overseas

Elliott MCS 920 B General Purpose Computer

Elliott Automation
London, England

The Elliott MCS 920 B is a second generation military computer which embodies in its design and construction the experience gained from the use of the first generation of MCS 920 computers in military environments. It is the successor to the MCS 920A.

The central processor is mounted in a sealed case and is built to withstand a military environment to British DEF 133(L3)(N2) or (A2). The sealed unit is 3 cubic feet in volume (0.08 cubic metres), and cooling is achieved by radiation from the skin of the case. The upper ambient temperature limit is +55°C and the relative humidity limit is 99 percent.

In order that the many on-line applications may be met, the computer is provided with four levels of program priority and interrupt facilities. Address modification facilities are provided for all levels of priority; the normal internal storage is 8192 words, each of 18 digits, but this can be increased externally to 65,536 words by the addition of extra blocks of 8192 words. When extra storage units are added the Autonomous Data Transfer facility may be used by external peripheral equipments. This facility alloys the transfer of data between store and peripherals without reference to the central processor and therefore permits transfers to occur concurrently with computation.

The computer requires nominal 24-volt dc supplies and is therefore ideally suited to both air and ground-borne applications. The consumption is only 120 watts and the computer will accept voltages between 20-30 volts dc. It is fully protected against short duration (5 minutes) main failure and noise.

IFIP ALGOL and FORTRAN packs are both available for this computer, and a Symbolic Input Routine (SIR) and TRACE diagnostic program are provided. Backing by the Elliott organisation includes very experienced programming groups with extensive know-how and special knowledge of military problems.

The Elliott MCS 920 B is compact, versatile, extremely reliable, and specially designed for use in demanding military environments. Silicon planar semi-conductors are used throughout and achieve high reliability and long life by operating at less than 10 percent of their rated value.

The use of a sealed unit achieves compactness and ruggedness and avoids the complications and penalties in size and weight of blown air cooling. The low power consumption permits the computer to operate from batteries, or to continue working in the event of mains interruption by using a small battery as a buffer.

The computer is also manufactured in a civil, or standard, version which is designed for use in 19-in. rack mounting, and a desk version for use in offices, and so on.

The Elliott MCS 920 B is claimed to be the cheapest computer in the world to offer such a wide variation of special features, combined with high speed and very small size, and manufactured to military standards.

Miscellaneous

Rapid Generation of Letters and Images

Bell Telephone Laboratories
New York 14, New York

A system of generating and setting any style of type – in any language – on the screen of a television-like (cathode ray) tube has been invented at Bell Telephone Laboratories. This system already has been used to generate and set 150 letters a second of typewriter quality. The method has the potential of generating and setting several thousand characters a second, much faster than any other way of setting type, with a quality comparable to that of book type.

The new system also makes it possible to produce a great variety of typefaces, line drawings, mathematical equations, musical scores, and scientific graphs. Images or letters displayed on the screen are photographed and the film negative then can be used to make, by conventional techniques, a plate for subsequent printing.

Developed by Dr. Max Mathews, Director of the Behavioral Research Laboratory at Bell Laboratories, the new system has been implemented in an experimental setup that includes a digital logic network, a cathode ray tube, and a camera. For this setup, Bell Laboratories made use of a General Dynamics SC 4020 Computer Recorder, a device that forms characters on the face of a cathode ray tube by firing an electron beam through corresponding characters in a stencil. In the experimental arrangement at Bell Labs, the beam is fired through only the period of the stencil. The digitally controlled beam traces small segments or "patches" on the screen. Although the patches rapidly disappear, they are captured on film by a camera set for a time exposure. Letters and images are built up on the film negative from these small segments appearing and disappearing on the cathode ray tube.

The shapes of the patches and the way they must be stacked together to form letters and images are stored as digital instructions in the network's memory. Dr. Mathews and Dr. Henry McDonald, Head of the Signal and Information Processing and Research Department, originated a way of keeping these instructions to a minimum. Carol Lochbaum, a consultant to Bell Laboratories, wrote the logic program.

The system is considerably more flexible than any other way of setting type. In other methods of type setting, type faces are stored as shapes on metal, glass, or film. To change styles, it is necessary to manipulate metal forms, glass wheels, or strips of film. In the new Bell Laboratories system, the type faces are stored in digital form. To change type faces, only the program instruction must be changed. A change could be made quickly, for example, from English to Chinese characters.

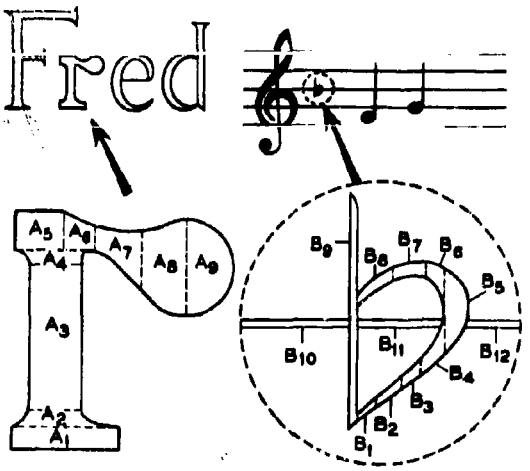
In the present experimental system, copy is typed on a keyboard directly connected to the logic network. The operator first indicates the type style he wants; the network selects the style from its memory, and then, as the copy is typed, the network generates the copy on the cathode ray tube screen in justified columns. (A justified column is one in which the type fills the width of the column as in most newspapers and magazines.)

In the new Bell Laboratories type and image generating and setting system, copy is formed on the screen of a cathode ray tube. The letters and images are formed from a series of rapidly appearing and disappearing segments called "patches;" see Fig. 1. These segments are put together like a jig-saw puzzle so that when a time exposure of the screen is taken, the desired letters or images are captured on film.

In these drawings, the letter "r" and the musical flat sign are shown made up of such patches. The size and shape of the patches vary with each type face. Because only a few instructions are needed to describe each patch, letters and images of high quality can be formed rapidly.

In the new Bell Laboratories' type generating system, letters or images are formed in this way:

First, a programmer chooses the image or type face he wants "stored" in the system. He



has these images or letters enlarged on paper on a scale corresponding to the size of the cathode ray tube on which they will eventually appear. Next, he divides the letters or images into a minimum number of patches of various sizes and shapes. Each patch preferably has a flat top and bottom, parallel to each other, and curved sides. Then, the programmer reads the coordinates of these patches, as scaled on the paper, and feeds the measurements to the system's electronic memory. Each patch's shape and size and its position on the screen is described in digital form. This information is stored along with the general program of instructions which tells the system how to form patches and put them together.

When the operator types out copy on a typewriter connected to the logic network, digital instructions in the network's memory directs the cathode ray beam to sweep within the described area on the phosphor-coated screen, causing it to fluoresce in the shape of the desired patches. The path of the zig-zagging electron beam is determined by eight coordinates. These specify the horizontal and vertical positions of one corner of the patch, the width of the bottom, and the height, slope, and curvature of each side. On the average, 12 patches are needed to form a letter. A camera mounted in front of the screen takes a time exposure of the rapidly appearing and disappearing patches. The patches, put together like a jig-saw puzzle, show up on the developed film as letters and other images.

Graphical Displays via Telephone Lines

Bolt, Beranek and Newman, Inc.,
Van Nuys, California

At the 1965 Fall Joint Computer Conference, Bolt, Beranek and Newman (BBN) introduced and demonstrated its new Teleputer (TM) System, the industry's first commercial man-machine communication system capable of transmitting graphical information over ordinary telegraph and telephone lines.

By using novel coding and logical techniques, the Teleputer System can generate complex displays while transmitting a minimum amount of information. Bandwidth compression of an order of magnitude has been realized in display generation, permitting normal telephone communication lines to handle 16 or more independent displays simultaneously.

Both alphanumeric and graphical information, in the form of lines, drawings, functions and arbitrary forms, can be communicated simultaneously in two directions between the user and the computer, if desired.

The Teleputer is being manufactured under license from The Bunker-Ramo Corporation.

In announcing Teleputer, Dr. William J. Galloway, BBN Vice-President, described its present configuration as an evolutionary growth stemming from concepts that originated some 5 years ago at Bunker-Ramo. Dr. Glenn Culler, now Associate Professor of Mathematics at the University of California, Santa Barbara, and Dr. Burton D. Fried, now in the Physics Department at the University of California at Los Angeles, have both been closely associated with the development of Teleputer's predecessors.

Sixteen Teleputer consoles are now in operation at UCSB under Dr. Culler's direction. These units are linked to the university's computing system, but Galloway stresses that Teleputer systems can be tied to any general purpose computer.

The initial applications of Teleputer are in the performance of "classical" mathematical computations such as the solution of differential and integral equations. Galloway said that from the user's standpoint, the ease with which Teleputer enables a mathematics-oriented operator

to solve analytical problems of arbitrary nature and great complexity, makes the system sometimes seem to be more powerful than the largest presently available computer.

For example, Teleputer permits a user to manipulate both real and complex numbers in the solution of extremely complicated problems; further, a user can evaluate his problem-solving strategy in mid-course by getting direct feedback of partial results. This capacity tends to give the user not only higher efficiency but also encourages him to exercise his mathematical intuition by guessing and playing hunches in ways that are normally forbidden by the economics and time factors of conventional systems.

The man-computer link in a Teleputer system is a Teleputer Console, which has a keyboard labeled and connected so that the user (in the case of mathematical applications) deals with functions as entities rather than individual numbers. The console keys are connected to computer subroutines which comprise an instruction repetoire of the basic mathematical operations of classical analysis.

By simple keyboard operations at the console the user can elaborate any of the basic subroutines into new ones that are specialized for his needs. These can, in turn, become parts of still more complicated, individually specified subroutines "programmed" by the user at the console. Thus the system is adapted for direct use by the scientist and does not require the generation of complex computer programs.

Other Teleputer System elements are the Data Set Control Unit, which provides the computer interface for the Teleputer System, and the Teleputer Control Unit, which controls a number of Teleputer Consoles. The Data Set Control Unit and the Teleputer Control Unit are interconnected by a Type 201 telephone data set, which can be furnished in models capable of transmitting 2000 bits per second or 2400 bits per second, depending on the user's requirements. Interconnection between the data set terminals is specified as the full-duplex private line mode, the half-duplex mode, or the message unit dial-up mode, depending on system requirements.

Bolt, Beranek and Newman, organized in 1948, is engaged in theoretical and applied research in airborne and underwater acoustics, fluid dynamics, mechanics and dynamics of materials and structures, electronic instrumentation, engineering psychology, information systems, and psychoacoustics. BBN manufactures teaching machines, computer input-output equipment, dynamic control equipment, and specialized instrumentation.

Corporate headquarters of BBN are in Cambridge, Massachusetts. West Coast facilities consist of a total of 20,000 square feet of office and laboratory space at Van Nuys, California and the Data Equipment Co. in Santa Ana, California.

Computer Status Information

Carnegie Institute of Technology
Pittsburgh, Pennsylvania

The Carnegie Institute of Technology campus radio station WRCT is now carrying the hourly turn-around information currently available from the Computation Center. Residents of the dorms and persons who spend a portion of their working day on campus are finding WRCT a convenient and inexpensive method of keeping informed regarding computer status. Current plans are to broadcast the information on the hour. The Computation Center appreciates WRCT's precedent-setting action in this regard. This service is believed to be a first, both for the radio station and the Computation Center.

Turn-around time is announced every hour on the hour while the station is on the air:

7:00 pm	– 12:00 midnight	Monday through Thursday
4:00 pm	– 3:00 am	Friday
12:00 noon	– 1:00 pm	Saturday (Turn-around will not be announced during football games.)
11:00 am	– 3:00 am	Sunday

Traffic Flow Simulation

Cornell Aeronautical Laboratory, Inc.
Buffalo, New York 14221

The complex traffic flow dynamics of an urban highway intersection are being reproduced in a computer by researchers at Cornell Aeronautical Laboratory. By representing with computer simulation the interactions of drivers, cars, roadway environments, and traffic controls, the scientists hope to find clues for improving the safety and efficiency of urban intersections.

The research project, sponsored by the U.S. Bureau of Public Roads, as part of its highway research and development program, will include detailed observations of actual intersections and driver behavior to add information to the computerized representation and to test the validity of the resultant model.

Computer simulation, a method for dealing in an orderly manner with all the known and measurable factors of a particular process or system, has been used by scientists for many years as a research tool. In the last few years, engineers from several research organizations have developed computer models to study various aspects of highway operations. These models, however, have dealt with limited situations involving relatively few variables and have not dealt in detail with the driver as a part of the system.

Recently, scientists in Cornell Lab's Transportation Research Department developed and successfully demonstrated a computer model of a simple highway intersection involving the driver, the vehicle, and the intersection geometry.

The model represented a four-way, single-lane intersection without traffic controls. Two simulated cars may approach the intersection in bi-secting lanes. Deceleration, acceleration, stopping time and distance, perception time, viewing angle, location of obstacles to line-of-sight, weight of cars, road surface friction coefficient, and driver decision-making, and reaction time were some of the factors included in the model. CAL scientists have used this model to simulate a number of intersection conditions and have been able to predict the occurrence or nonoccurrence of a collision.

In addition to laying the groundwork for the new study, the original computer model pointed up the importance of the viewing angle between the intersecting cars to the decisions of the drivers. Not surprisingly, how far ahead the driver considered the consequences of his actions was also found to be highly significant.

The current program will aim at extension and refinement of the simulation including human and vehicular characteristics, more detailed geometry of the intersection, sight and traffic obstructions, added traffic volume, and type and degree of traffic control. In order to more closely represent the real situation, traffic control will range from the two-way stop signs to four-way traffic lights.

Driver behavior is considered by the CAL scientists to be, by far, the most difficult factor to represent. Behavior variables have been formulated as assumptions about the perceptual, decision making, and information processing of the human. These assumptions have yet to be validated and CAL proposes to do so by studying driver behavior in detail through the use of a separate laboratory simulator and an instrumented car it recently developed.

CAL also plans to observe actual intersections, instrumented to provide detailed information on traffic – complete time histories of vehicular movements.

It is proposed that the traffic controls at one or more test intersections be changed periodically to determine the effects of different systems. Full-scale simulation with a mock intersection will also be conducted for experiments in a highly controlled situation where emergency conditions can be created without any real hazard to life or property. In this way too, CAL plans to simulate intersections of varying shapes to study the influence of geometry on intersection dynamics. Laboratory simulation will provide basic data on related perceptual and information processing capabilities of the human.

Ultimately, the CAL researchers will be attempting to answer the question, "What makes a good intersection from the standpoint of traffic capacity and safety?" They point out, for example, that the safety records maintained for many intersections are valuable to a degree but offer no solid information on why one intersection is safer than another. Intersections have tended to evolve from experience, common sense, demands of the public, and technical studies dealing with small segments of the overall problem, such as traffic volume. More desirable, according to the CAL scientists, would be the initial construction of intersections on the basis of a body of technical knowledge, or at least a more complete understanding of how intersections work.

Computer modeling is believed by Cornell Lab to be a promising approach for generalizing the intersection problem. Computers, with vast capacities for calculation, can simulate an enormous variety of intersections and intersection conditions which would take years and extensive funds to accomplish with full-scale experimentation. In studying the effects on intersection performance of particular factors, the computer model can only simulate real life according to the assumptions and numbers programmed into it. It cannot generate new formulations on its own. Because of its immense storage capability and high calculating speed, however, it enables the experimenter to examine situations, which in their totality, are too complex for representation by other means.

Computer Training Classes

State of Georgia
Clarkston, Georgia

In October 1965, William M. Hicks, Georgia's state supervisor of trade and industrial education, announced the installation of two new Honeywell 200 computers at two of the state's recently established vocational-technical schools.

"The computers are among the first advanced, high-speed systems in the nation to be acquired for classroom use," Hicks said. "They are intended to help meet the growing demand in Georgia for people able to understand and operate computers. We do not intend to find ourselves teaching today's students the obsolete skills of yesterday. We are preparing them for tomorrow."

The H-200's are installed at the DeKalb and Marietta Cobb area vocational-technical schools.

The two schools made thorough surveys of current and future job opportunities in Georgia before deciding to purchase full-scale computers for classroom use, according to Loyd Cox, Cobb county school superintendent.

Cox said a survey made in and around Atlanta in November 1964 revealed:

1. There were some 700 data processing installations in Georgia;

2. At least 1500 new positions or job vacancies had had to be filled during the previous year; and

3. An additional 5000 new people would be required during the next 5 years.

Jim Cherry, DeKalb county school superintendent, described the schools' two-year courses in data processing technology as a series of building blocks, beginning with basic concepts and concluding with a field project in which the students actually work with a business or industrial firm, studying its data processing requirements.

"Our graduates will not be novices needing great amounts of on-the-job training," Cherry said. "They will be competent, experienced data processing people fully equipped to step right into their new jobs and earn their salaries."

Georgia is establishing 28 area vocational-technical schools through the joint efforts of the state department of education and the boards of education of the various counties involved. Sixteen schools are now open or nearing completion. Their purpose is three-fold:

1. To help high school graduates develop technical and vocational skills in new and expanding fields;

2. To train employees for existing and future companies in Georgia; and

3. To provide currently employed workers an opportunity to upgrade their skills for better jobs, and retrain employees whose jobs have become obsolete because of technological changes.

In addition to data processing, the schools offer high school graduates 1- and 2-year courses in electronics and electrical, mechanical, and chemical technologies. Eleven skilled-trade and clerical occupations are also taught. These include such subjects as drafting, radio/television service, practical nursing, and secretarial sciences.

Mr. Hicks, the state supervisor of trade and industrial education, said Georgia's growing emphasis on data processing education in its vocational-technical schools is an important facet of "our determination to accomplish two

primary missions – to prepare our young people for today's rapidly changing world of business, commerce, and technology; and to provide the highly skilled labor force Georgia needs to attract and keep industry."

Cobb county school superintendent Cox said the H-200 computer systems have the built-in flexibility to handle additional or new types of equipment to meet course requirements that cannot now be anticipated. "We have no intention of permitting either our methods or our equipment to become outmoded and out of touch with the changing needs of business and industry," he said.

The DeKalb and Marietta-Cobb computers each have a main memory able to store 16,384 alphanumeric characters of information, a high-speed printer, and card reading and punching units. The DeKalb computer also has a separate "random access" mass memory able to hold 2.6 million alphanumeric characters of information.

During the EDP students' first year in school, concepts fundamental to the use of computers and punched card tabulating equipment are studied. Also included are elementary accounting, business, and data processing mathematics and communication skills.

The second year concentrates heavily on computer programming, programming systems, computer applications, and business systems design and development. The focal point of the various courses is actual work with the Honeywell 200. Other courses during the 2 years cover advanced accounting, economics, business psychology, and business statistics.

None of Georgia's vocational-technical schools charges tuition to full-time day students. Students are required, however, to pay for books and supplies, which amount to about $100 a year. Expenses for evening students are lower due to the shorter length of courses.

PLATO

Coordinated Science Laboratory
University of Illinois
Urbana, Illinois

INTRODUCTION

The purpose of the PLATO project (DCN, Oct. 1961, July 1962, Apr., July, Oct. 1964, and Jan., Apr., July, Oct. 1965) has been to develop an automatic computer-controlled teaching system of sufficient flexibility to permit experimental evaluation of a large variety of ideas in automatic instruction including simultaneous tutoring of a large number of students in a variety of subjects. The PLATO system differs from most teaching systems in that the power of a large digital computer is available to teach each student since one such computer controls all student stations. The project work has three phases, no two of which are wholly separate from each other:

1. Development of the tools for research;

2. Learning and teaching research;

3. Provision of a prototype for multi-student teaching machines.

An ever-increasing amount of the time of the PLATO staff is also spent demonstrating the PLATO system to technical visitors and colleagues. In all the categories of its research, the PLATO group has interacted frequently with various other groups at the University of Illinois that are concerned with curriculum studies, college teaching, and behavioral science research.

PLATO III SYSTEM EQUIPMENT

During the second quarter 1965, work continued in the development and construction of circuitry required for the realization of a 20-student station teaching system.

Student-station circuitry constructed to date includes that required for the full operation of 10 student stations. Construction of the remaining to complete the 20-student-station system continues and is expected to be completed by early 1966.

Developmental work required to update present system circuitry or to provide new system facilities continues to be under study. Included are transistor deflection-circuits that will replace existing vacuum-tube types operating in storage-tube and flying-spot scanner

equipments, and audio-storage circuits to provide for random-access audio-readout capability for all student stations in the PLATO teaching system.

PLASMA-DISCHARGE DISPLAY-TUBE RESEARCH

The purpose of the plasma display-device is to develop an inexpensive replacement for the present student storage-tube system. This quarter, tubes were constructed with different widths and hole diameters. Preliminary analysis of the data indicates that the minimum permissible operation voltages occur when the hole radius and the cell thickness are equal. Work is continuing on the investigation of the memory mechanism. Various gas additives have been tried, and in some cases separation between the firing and sustaining voltages of 100 percent have been observed. Cells as small as 0.01 inch by 0.02 inch have been investigated.

PLATO LEARNING AND TEACHING RESEARCH

A New PLATO Tutorial Teaching Logic

Major changes have been made in the teaching logic developed during the spring semester 1965, for the section of the course in circuit analysis, EE 322, given using the PLATO teaching logic (see section below). The logic provided the students with the ability to read material, answer questions with constructed responses, ask for help, plot graphical results that were dependent upon their own parameter inputs, and make comments. The logic with its modifications has proved general enough to teach lesson material in other areas than circuit analysis so it is now known as the new PLATO Tutorial Logic. It has been used for both the course in FORTRAN Programming for Commerce Students and the course in How to Use the Library (see sections below).

The major changes in the logic program include the following:

1. The maximum length of an answer has been extended from 14 characters to 69 characters. Answers longer than 69 characters may be plotted on the screen, but will not be stored in the student bank,

2. A spelling judger in addition to other judges has been added. For a misspelled answer, "SP" will be plotted next to the answer when judged, instead of "NO."

3. Lesson parameters can now be stacked up on one magnetic tape instead of requiring one tape for each set of parameters.

4. There is now a second way to introduce lesson parameters into the program. Instead of putting parameters on-line from the keyset, a paper parameter-tape can be prepared on the flexowriter and then read into the computer along with the master program.

Electrical Engineering 322 – Circuit Analysis

A new set of PLATO lesson materials for the electrical engineering course, EE 322, is being written with half the course having been completed during this quarter. The new set of lessons will teach the complete course using the PLATO system in contrast to last semester's procedure of one-half the course with PLATO, one-half in the classroom. The students will meet 4 hours a week. Three hours will be spent using PLATO with the remaining hour being used for hour exams and problem-discussion sessions. No complete class section will be taught using the PLATO system until the second semester of 1965-66, at which time the additional 10 PLATO stations will be operative. Experimental groups of students will be tested this fall, however, using various portions of the EE 322 course materials.

Text-Tester

As a result of preliminary reports during the spring, the generalized, student-controlled, PLATO teaching logic called TEXT-TESTER has been completed, except for annotations and minor modifications. As only one of its multiple uses, TEXT-TESTER is now being adapted for use with a Braillewriter (braille typewriter) in order to experiment with training sighted volunteers to transcribe printed materials, exams, and so forth, for blind students.

An adapter has been built to sense braille characters and transmit them to the computer, and special subroutines for plotting braille characters have been prepared. Although eventually it seems likely that the difficulties of automatizing the transcription process will be overcome, the training of sighted volunteer braillists meanwhile is an active concern of the University Rehabilitation Center and appears

to provide an opportunity for experimentation with PLATO in the training of a technical skill.

An inquiry-type program, TEXT DOPE, to permit authors to examine student responses to TEXT-TESTER is being coded.

Proof

The program called PROOF, which is a generalized version of an old ILLIAC-language program, is nearing completion. It is hoped that it may be ready for use with University High School UICSM mathematics classes this winter.

Arithdrill

The new teaching logic that provides timed drill in arithmetic with repetitions controlled individually by pupil success has been revised. This program, called ARITHDRILL, is expected to be used in connection with UICSM classes this fall.

FORTRAN Programming for Business Students

The purpose of this experiment is to investigate programmed methods for teaching computer programming using the FORTRAN language. Particular emphasis is being placed upon an investigation of the types of difficulties faced by business students while learning to program computers.

During the past semester a major portion of the teaching material was developed. Using the new PLATO Tutorial Logic, the parameters were put on tape and tested. Two groups of elementary accounting students worked through the first 10 units. The data derived as a by-product of student actions are currently being analyzed in preparation for additional trials during the fall of 1965.

Library Science 195

A course, "Introduction to the Use of the Library," (known as the LIBUSE program) was written for the PLATO system for the fall semester. The course consists of 14 units and covers the content of Library Science 195, a course on how to use the library.

During the months of July and August, eight test runs were made on various units. As a result of these test runs the needs were evident for a spelling judger and the inclusion of the selective-erase, in addition to the total-erase, facility. Subroutines for these effects were subsequently added to the new PLATO Tutorial Logic.

The library-science course will be the first credit course at the University of Illinois to be completely taught using the PLATO system.

Learning and Retention of Verbal Materials

During June and July, 60 subjects participated in an experiment on retention of conceptual material, begun during the previous quarter. The flexibility of the PLATO system allowed individualized subject treatment and complete automatic recording of the data. Except for one power failure, data was accumulated smoothly. Data analysis is in progress.

VERBOSE Program

The PLATO program, VERBOSE, was developed as an exercise in the use of the CONNECT feature of the PLATO compiler, CATO, and as a first step toward more general PLATO programs that would be useful in studying the structure of concepts.

The VERBOSE program records the keyset activities of two subjects, A and S. Subject S generates a string of (stimulus and response) words by partially free association, after A gives him the first word. The screen for S displays the last word that has been added to the string of words and a new word as he types it. The screen for A displays the last two words in the string of words and the link word that he types. The link word is supposed to indicate in some way the relationship that A sees between these last two words. Each types a "period" to indicate "end of word." Each is guided by instructions on PLATO slides.

Design of the VERBOSE program suggested a method of analysis of mode states and mode transitions in PLATO programs that use CONNECT. The VERBOSE program and a few simple results of this analysis are described in CSL Report I-129.

Computer-Aided Crime Detection

City of New York Police Department
New York 13, New York

In December 1965 the New York City Police Department announced the results of "Operation Corral," a 5-month experiment in the use of a real time computer in the identification and arrest of automobile and license plate thieves and scofflaws.

Assistant Chief Inspector George P. McManus, Chief of Planning, said, "In 158 days of the experiment, working 8 hours a day, 'Operation Corral' checked on 183,950 cars."

"Of these, 2932 were found to be wanted either on alarms for stolen cars or plates, or on warrants as scofflaws.

"165 individuals were arrested, 102 on alarms and 63 as scofflaws.

"In addition, 68 'hits' were made on the license plate numbers of scofflaws with New Jersey registrations and 93 persons wanted here on revocation or suspension of license orders.

"These results indicate an important use of the computer as a modern-age tool for police. The computer has a broad and valuable application in many areas of law enforcement and crime prevention. In this experiment it has supplied an important means of obtaining information for more efficient law enforcement. The results of 'Operation Corral' are now being studied, and upon completion, further recommendations will be made."

The experiment utilized a Univac real time computer which was based at the United States Building at the World's Fair.

A total of six members of the force handled the operation. This team consisted of two radio car patrolmen acting as an observation team, two radio car patrolmen acting as the apprehending team, and two acting as teletype operators feeding information into the computer regarding stolen cars and plates, scofflaws, and revocation and suspension orders.

As automobiles passed a fixed point, usually upon a highway, bridge or tunnel, the observation team radioed license plate numbers to the team of two officers at the teletype machine. The patrolmen receiving the information teletyped the numbers into the computer, which provided an answer within seconds.

If a "hit" was made, this information was radioed to the apprehending team which stopped traffic, thus blocking the escape of the wanted car. The apprehending patrolmen then circulated through the stopped cars until the wanted car and driver was located. This method avoided the chasing and cutting off of the wanted car.

Chief McManus pointed out that it is technically possible to eliminate the teletype personnel, by having the inquiry made directly from the policy radio car to the computer via radio teletype. During a trial period using this method of direct communication, three arrests were made.

He also pointed out that should three teams of two radio cars each be placed on the streets of the city, it would be feasible to check two and a half times the number of registered vehicles in the city in 1 year.

He also pointed out that during the experiment, 31 of the 102 arrested had criminal records, and that several of the apprehensions resulted in investigations leading to additional charges in this and other jurisdictions, and additional arrests. 102 of the arrests resulted in 212 additional charges. Eighty-three percent of the cases concluded have resulted in convictions. Among the additional charges placed were such crimes as possession of narcotics, possession of policy slips, grand larceny, robbery, and forgery.

A continuing investigation into a motorist stopped in the Bronx resulted in the following charges, arrest for a forged registration, two charges of grand larceny, one for cash and the other for a motor vehicle, and forgery of a driver's license.

In another case, the operator of a stolen car was additionally charged with a narcotics violation: possession of a hypodermic needle and eye dropper.

The operator of another vehicle flagged down by the computer was found to be wanted in New Jersey for robbery.

An operator stopped by the "Operation Corral" team was hit with additional charges of forgery and possession of stolen property. An admitted drug user, the defendant had a previous record of 16 arrests.

Chief McManus said, "One of the major objectives of 'Operation Corral' was to develop not only an instantaneous and multiple query

and response identification of stolen vehicles but also to induce the public to comply voluntarily with the traffic laws and the regulations of the Motor Vehicle Department.

"In this regard, the records of fines paid and voluntary surrenders on Traffic Court warrants are being examined as are the volume of surrenders of suspensions and revocations received from the New York State Department of Motor Vehicles.

"The effectiveness of the foot patrolman will be enhanced by placing at his disposal by means of the computer a vast pool of information that should result in fewer crimes and a higher clearance rate. Information and intelligence can be disseminated to foot patrolmen on a periodic basis so that they may take preventive action or follow-up possible leads when alerted to new crimes or possible violations. The auto thief, the traffic scofflaw, and the possessor of forged driving licenses or registration certificates should be among the first violators apprehended and deterred from repetition of such acts in the future.

"The gambling fraternity and organized criminals also will soon learn that their advantage of mobility has been overcome to a large extent. The inevitable result of a computerized mass of police information will be a synthesis of data that will both facilitate and make more meaningful the job of the foot patrolman.

"The possibility of increasing efficiency by the application of computers and electronic systems to police operations and tactics is most promising. Although the path ahead will be blocked with many great obstacles, they will not be insurmountable."

Computerized Guaranteed Annual Income

New York Shipping Association, Inc.
New York 4, New York

The computer is coming to the waterfront shortly to help ensure longshoremen prompt, accurate payments of the annual income guarantee negotiated earlier this year.

The New York Shipping Association and International Business Machines Corporation have signed a contract which will put the power of IBM's System/360 to work at handling the complex plan. IBM will install the system, which will have 56 terminals in the Waterfront Commission Hiring Centers. It has been designated "Operation GAI" (Guaranteed Annual Income).

"Administering the thousands of details that will go into making the guaranteed annual income plan work would not be possible without a computer system," said Alexander P. Chopin, chairman of the New York Shipping Association.

"It is a guarantee of accurate payments to the longshoremen on top of the guarantee of the annual income itself, as provided in the present labor contract. It is the first time, that a computer will be utilized to facilitate the hiring of longshoremen and ensure an adequate labor supply in the Port of New York.

"We are making certain through this system the successful administration of a contract arrived at after a 33-day strike that cost the nation an estimated $3 billion in economic losses.

"The new agreement, negotiated between NYSA and the International Longshoremen's Association, assures labor peace in the Port of New York for a 4-year period, provides for a stable and economically secure work force and sets a basis for cargo cost controls and promptness of ship movements so essential to the national economy and our import-export trade position. This contract implements the major findings of a year long study by the U.S. Department of Labor on ways to improve labor efficiency in the Port."

The income guarantee provided for the Port's longshore work force, as job protection under the new work practices, goes into effect April 1, 1966. It was a key factor in reaching agreement on the new contract.

The guarantee for eligible ILA members, calls for the equivalent of 1600 hours pay annually at the straight time rate, or an average of about 32 hours a week. At the present hourly rate of $3.46, this is equivalent to an annual income guarantee of more than $5500, or over $100 a week, to eligible union members.

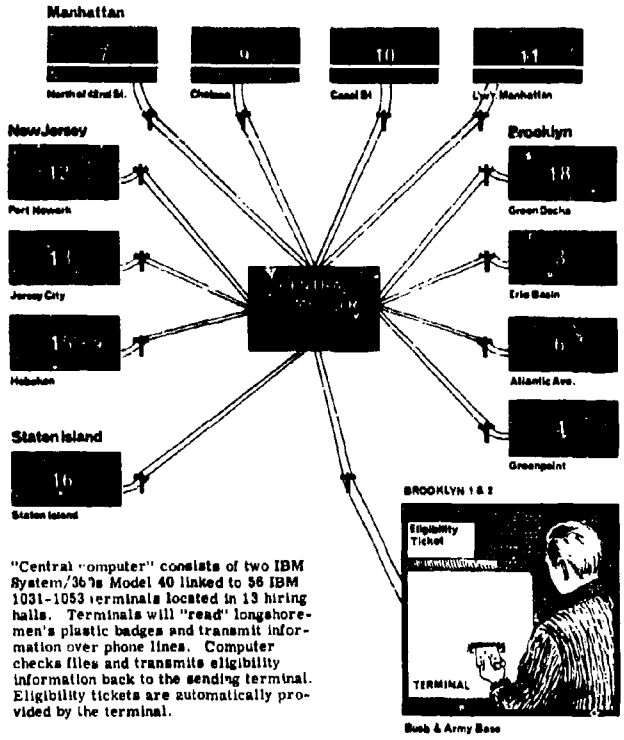


Figure 1--Longshoremen ordering and registration system

The central computer, dual System/360 Model 40's and the extensive files will be linked to 56 data collection terminals in 13 Hiring Centers. Hiring of many casual longshoremen is done at the Centers, located in Manhattan, Brooklyn, Staten Island and New Jersey.

Each longshoreman now carries a plastic, wallet-size seniority card. When the computer system becomes operational next April, the longshoreman appearing for work call will insert a similar card into the computer terminal at the Hiring Center, Fig. 1. In seconds, the computer will check its records, verify that he is eligible for work and automatically issue him an eligibility ticket for that shape-up session. This will guarantee each longshoreman that he has been recorded as having appeared at the center ready, willing, and able to work.

If no work is available for him at that Center, the computer will poll the manpower needs, if any, of the other 12 hiring halls and print out a list immediately. This will ensure that if there is a job opening in the Port, the man eligible to fill it can be hired almost immediately.

During the busy periods on the docks, as many as 7,000 longshoremen may appear at the hiring halls looking for work. Information on all of them must be collected, checked, and recorded.

"We were confronted by an enormously complicated problem in keeping up to date the work records for the Port's 24,000 waterfront workers," Mr. Chopin said. "Many men presently work for more than one employer. They may appear for work during any one of three daily hiring periods at any of the 13 hiring halls. While most workers are hired for an eight-hour day, a large percentage are employed for either shorter or longer periods.

"Faced with these variants in the daily work pattern and the possibility of human error in recording and transmitting data, we realized that the task of administering the income

guarantee would be overwhelming, with complaints from the work force sure to arise if information were incorrectly reported.

"Fortunately, we have been able to solve the problem through this IBM computer system. The task has not been an easy one and has covered nearly a year of daily study by specialists in the computer field. The cost to the employers in the Association will be $1.3 million in the first year alone, which is an indication of how important our 145 member firms, who hire waterfront labor consider accurate and prompt payments to the workers."

The actual payroll for hours worked remains the responsibility of each employer. The Association representing the employers as a group, administers the guaranteed annual income. Payments under NYSA's Operation GAI will be made to workers each quarter. Seventy-five percent of the amount due will be paid, and the worker's account will be finally balanced and closed out at the end of each contract year. The funds to support the guarantee are paid by the employer-members of NYSA.

To be eligible for the guarantee, an ILA member must have worked a minimum of 700 hours during the 12 months from April 1, 1965 to March 31, 1966.

Computerized Typesetting

The Daily Oklahoman – Oklahoma City Times
Oklahoma City, Oklahoma 73101

Two small but fast and powerful computers have been ordered by the Oklahoma Publishing Company for setting type for all editions of its daily newspapers.

The twin machines, ordered from International Business Machines Corporation, will replace a larger system installed 2 years ago. The new computers – IBM 1130's – are expected to produce a saving in rental costs to OPUBCO of approximately $1500 a month while more than doubling typesetting capacity, according to Robert B. Spahn, production manager for the Oklahoman and Times. Mr. Spahn said installation of the dual systems is scheduled for early 1966.

Each of the 1130's can produce justified and hyphenated paper tape for automatic typesetting machines at up to 12,000 30-character lines an hour. The present system operates at about half that speed.

"The pair of machines will give OPUBCO the capacity for producing 24,000 lines per hour at a 30 percent reduction in rental costs, which was the primary reason for ordering the new equipment," said Mr. Spahn. "The additional typesetting capacity is needed during peak periods and when we are up against deadlines."

The dual system arrangement is also advantageous during normal machine maintenance periods and in the event of a breakdown of one of the machines.

OPUBCO was one of the pioneers in developing the computer typesetting application. The March 5, 1963 issue of the Oklahoma City Times was widely heralded as the world's first newspaper in which all copy was produced by a computer.

Today, OPUBCO routinely uses its computer to set some 5200 column inches of type every day for the morning, afternoon, and Sunday editions of the Times and the Daily Oklahoman. Both editorial and classified ads are being set automatically.

Mr. Spahn said the present system is also being used for photocomposition, an application only recently developed. Similar to the linecasting operation, the teletype operator includes a series of short codes in the paper tape. These instructions are recognized by the computer which determines font, size, measure, and position of copy on film or paper. The punched tape is then fed directly to the photocomposition machine.

"Through this method, we are able to go directly into 'cold type' on display advertising, bypassing hot metal," said Mr. Spahn. "This greatly increases productivity. The new equipment will handle this operation even more efficiently," he added.

The IBM 1130 can accept copy directly from as many as eight tape perforators. It not only hyphenates words, justifies lines and controls format, but automatically allots the processed copy to as many as eight paper tape punches linked to automatic linecasting machines. All

of this is done under control of a typesetting program developed by IBM and provided without charge to users of the 1130.

Another feature of the 1130 is a new disk storage device giving the computer direct access to any number of type fonts and to an "exception-word" dictionary. This provides the computer with 99 percent hyphenation accuracy based on first choice of Webster's dictionary.

The storage device uses magnetic disks capable of holding more than one million characters of information. Since disks are easily interchangeable, it will take only a few seconds to prepare the computer for a change in jobs.

Visual Display System for Carnegie Tech.

Philco Corporation
Philadelphia, Pennsylvania 19134

Philco Corporation has delivered a computer-driven visual display system to the Carnegie Institute of Technology Computation Center in Pittsburgh.

The complex cathode ray tube system, built to Carnegie Tech's specifications, was adapted from Philco's Real-Time Electronic Access and Display (READ) system.

The advanced system provides a highly effective method of real-time use of time-shared computers, Philco spokesmen said.

The Carnegie Tech system, consisting of a controller and three display consoles, permits the operator to manipulate high-resolution alphanumeric and graphic data in a volatile manner on the face of the cathode ray tubes. Jesse T. Quatse, Manager of Engineering Development at the Computation Center, was responsible for systems design at the university.

The university plans to use it for computer programming and program debugging; problem solving in engineering, mathematics, and science; and classroom instruction.

The system is installed in a classroom building 1000 feet across the campus from Carnegie Tech's present multi-processor computer system. A booster module and computer interface in the Computation Center drive the signals to the Philco display equipment in the classroom building.

Each of the three consoles is equipped with a cursor, a light pen, and two typewriter keyboards. The cursor is an electro-mechanical locator which enables the operator to place a locator spot on the face of the tube. With it, data can be inserted, altered or erased. The light pen can be used for the same purpose. The keyboards include all characters in the English and Greek alphabets, plus mathematical and special symbols.

The cathode ray tubes in each console have 80 square inches of viewable area (approximately 9 x 9 inches square). Information in one console may be simultaneously displayed on any of the other consoles, or each of the consoles may have a different display. Operators can insert, correct, or delete data as well as re-position, intensify, blink (on-off) or vary the size of the symbols displayed on the tube, without computer intervention.

A typical problem-solving application is the design and simulation of computer systems such as computers. A student can see the system he designed in operation on the face of the tube.

Philco's READ system, on which this Carnegie Tech system is based, is a product of the Communications and Electronics Division's Commercial Operation at Willow Grove, Pa.

Traffic Control Study

City of San Jose
San Jose, California

The first phase of a new experimental system is now operational and is automatically controlling traffic signals at 32 intersections along a major 3-mile highway and adjacent

streets leading into the downtown section of San Jose.

A.R. Turturici, San Jose city engineer, said preliminary results show a significant improvement in the methods of handling the flow of 35,000 cars that use the highway daily. The next phase of the study calls for the more complicated task of controlling 28 traffic signals located in a 35 square block area in down town San Jose.

The new computerized traffic system is the result of a cooperative study being conducted by engineers from the City of San Jose and International Business Machines Corporation.

The research project was launched to determine the most efficient and economical method of solving the city's traffic problems.

"With the speed and versatility of a digital computer," Mr. Turturici said, "it is possible to recognize immediately the rapid changes of traffic patterns and to respond within seconds.

"Moreover, the computer also provides complete reports of exactly how traffic responds to its commands, and can be revised by traffic engineers to eliminate unnecessary delays."

Mr. Turturici said the computer-generated reports are now being studied to determine the exact degree of improvement in the flow of traffic along the test route.

Gene Mahoney, San Jose assistant traffic engineer, said the IBM 1710 Control System receives information from 400 sensing devices buried beneath the pavement at the intersections involved in the study. As cars pass over these sensors a magnetic field is interrupted and a pulse is sent to the computer.

In this manner the computer is constantly aware of the number of vehicles, their speed, which lane they are in, the number and duration of stops, and the number of vehicles that pass a given intersection during each cycle.

The computer –

- receives the information about the flow of traffic from all sensors simultaneously;
- within seconds consults the many possibilities in its memory about how to reduce delay time and decides on a logical course of action;
- executes control by altering traffic signal timing cycles; and
- receives more information from traffic sensors to verify whether the action was successful before starting another cycle.

"By using a computer," says Mr. Mahoney, "all data can be immediately collected and analyzed in one central location. We can produce more information in a matter of seconds about the flow, speed, and other elements of traffic than a crew of trained observers could produce in hundreds of hours."

Paul Haddon, IBM project leader, says that the study, now in its second year, has provided volumes of information about how traffic patterns react under control of a computer.

"As the study progresses and we continue to learn, new factors will be added to the computer's programs," Mr. Haddon said. We hope to study all factors that affect traffic, such as pedestrian crossings, demands from side-street traffic, traffic variations during different weather conditions, rush hour traffic, and many others.

"As a tool for city planners, the system has unlimited possibilities. It could easily be used in predicting the need for freeways, to help prevent unnecessary street-widening projects, and to eradicate one of the major problems of modern American cities."

Hospital Information System

Santa Rosa Medical Center
San Antonio 7, Texas

The management of one of Texas' largest privately-owned medical complexes is helping to pioneer data processing operations to improve patient care in large hospitals everywhere.

Santa Rosa Medical Center hopes also to show the way for major hospitals to maximize control of hospital costs.

The 800-bed Catholic institution announced it has ordered an IBM System/360 Model 30, as the basis for a "Hospital Information System," (HIS) to be installed in 1967.

The HIS at Santa Rosa will provide electronic repository for all types of information, ranging from patient case histories and medical

records to the cost of drugs, any part of which can be retrieved in fractions of a second for use at any place in the hospital.

The power of the computer will be made available to every nursing station, laboratory, and major facility of the hospital – including its business and admitting offices – by installation of 30 IBM 1050 communications terminal devices at strategic points throughout the center.

"Any qualified person can ask for or enter any type of data at these terminals," Sister Mary Vincent, Administrator, said "For instance, when a doctor leaves his orders for medication and patient care, his instructions will be transmitted immediately to the computer through keyboard entry at the nursing station.

"If the orders call for tests or special foods or drugs, the computer also sends the necessary information to the proper laboratory technicians, to the kitchen, to the pharmacy, and so on.

"What's more," she added, "the machine retains the schedule in memory and sends out, 'reminder' messages when the time arrives for execution of each of the physician's orders."

The idea, Sister Mary Vincent added, is to give every hospital employee and every doctor at Santa Rosa the precise information needed to do a job and to make it available when and where it's needed.

Most important is the prospect of freeing professional personnel from the flood of paper that threatens to overwhelm hospitals everywhere, she said.

"At Santa Rosa, we have found that each of our 500 nurses now spends an average of 40 percent of her time – or more than three hours a day – doing paperwork, either gathering, shuffling, or recording information. We estimate our electronic system will cut the nurse's paperwork in half, increasing our effective nursing time by 20 percent.

"To put it another way, the impact will be about the same as if we went out and hired another 100 nurses," Sister Mary Vincent concluded.

The IBM computer system will also store historical data on magnetic tape. This means that statistical analyses recording incidence of illnesses by type, age, income group, geographic location, and so forth, can be compiled in minutes.

Because of this, Sister Mary Vincent thinks the HIS concept is destined to trigger a revolution in hospital management. "We are one of only a few hospitals actively at work to develop it today," she said.

She said hospitals have been so busy trying to stay current with patient loads and such critical problems as nursing shortages that they have fallen behind in the area of modern business systems.

As a result, they have become increasingly swamped by an accelerating "explosion" of medical knowledge which has multiplied by a hundred fold the facilities, tools, drugs, and techniques which may be used in patient treatment and care. This growing complexity has spawned increasing need for sophistication in attendant paperwork, control procedures, and management, she said, adding:

"We're investing heavily in our own judgment that the IBM computer-controlled Hospital Information System is the answer."

Hospital Information System

The Sisters of the Third Order of St. Francis
East Peoria, Illinois 61611

Patients in 11 Midwestern hospitals owned and operated by The Sisters of the Third Order of St. Francis will receive the benefits of the best possible medical care with assistance from an IBM computer complex.

Rev. Mother M. Pieta, O.S.F., mother general of the religious order of Franciscan Sisters, said a central data processing system valued at more than $4 million will be installed here to service the order's hospitals in Iowa, Illinois, and Michigan.

Medical, laboratory and administrative data on patients in the group's 2200 hospital beds will be transmitted over telephone lines from as far as 500 miles to the central computer for storage or processing. Information will be sent

and received via 154 special terminals at nurses stations, doctors offices, and service departments throughout the 11 hospitals.

Nerve center of the Hospital Information System (HIS) will be an IBM System/360 Model 50 and a smaller Model 30 computer which will be located at the order's central administrative office in Peoria. Central repository for all data will be the IBM 2314, a magnetic disk storage unit capable of holding more than 200 million characters of information for instantaneous retrieval.

The HIS will function as a –

- Communication system, centrally controlling the flow of information from originating sources to receive locations;

- Central information system, storing electronically in one place all data for access upon demand; and

- Real-time processing system, converting information into meaningful and useful forms, quickly and economically.

The HIS for The Sisters of the Third Order of St. Francis will be the first in the world designed to serve more than one hospital. Mother Pieta said the decision to lease the IBM system is part of the religious order's "unceasing efforts to improve the level of patient care." She said: "We, like most hospital administrators, realize that patient care depends largely on the quality and quantity of professional personnel available. Because of shortages of qualified personnel and ever-present budget limitations, we searched for a way to increase effectiveness of the current staff of professionals. In a comprehensive study undertaken by our central administrative office and International Business Machines Corporation, we concentrated on finding ways to automate clerical activities performed by the professional staff. An area of special study was the amount of time professionals, particularly nurses, spent on clerical duties vital to the performance of their jobs, but which did not require use of their medical skills. We found, for example, that our nurses spend 40-60 percent of their working hours on purely clerical duties. The decision to implement the Hospital Information System is our vote of confidence that the clerical workload of doctors and nurses can be minimized, leaving them more time for patient care and other medical tasks for which they were trained."

Herbert R. Rodde, executive director for the central administrative office of the order, said that in general the HIS makes provisions for centralizing and correlating large volumes of diverse data from many locations, and then automatically retrieves and displays it as necessary. He said that when the HIS becomes fully operational, the computer will link hospitals' nursing stations, clinical laboratories, pharmacies, blood banks, admitting offices, medical records units, business offices, and other departments.

Through the network of terminals in the hospitals, the computer will help admit patients, find them beds, order drugs, report results of lab tests, correlate X-ray and lab schedules, and plan special diets.

Operating room and testing and therapeutic facilities scheduling will be coordinated, and doctors will be furnished with current records showing treatment given and progress made by their patients.

Mr. Rodde said that areas in which HIS will have most impact are:

1. Fulfilling physicians' instructions. The computer, through terminals in the hospitals, will notify the staff of action prescribed by the doctor, at the time the doctor directs.

2. Scheduling. Information on all patient and facility scheduling will be introduced into the central system, which automatically will "flag" any conflicts.

3. Patient care. All physicians' orders – whether complete or in process – are stored in the central memory of the system and can be recalled by the hospital staff at any time. Selected medical test results and physiological measurements can be noted and retained.

4. Nursing activities. The terminals provide an immediate source of information on progress of all orders and instructions. Reminder notices of incomplete activities are automatically generated. Complete written reports are maintained on all activities in every nursing unit.

5. Administrative controls. Up-to-the-minute data on all patient charges are maintained in the system which also has the ability to retrieve pertinent information on unit costs resulting from patient care activities.

Mr. Rodde said that a preliminary telecommunication system using the IBM System/360 Model 30 will become operational in January 1967, a year before implementation of the total system. The interim system will provide for centralization of financial and administrative records.

Medical centers involved in the system are The Third Order of St. Francis' hospitals in Marquette, Escanaba, and Menominee, Michigan; Rockford, Pontiac, Bloomington, Peoria, and Galesburg, Illinois; and Fort Madison, Keokuk, and Burlington, Iowa.

The following objectives were set up as minimum requirements of the Hospital Information System.

General

1. All orders, schedules and messages must be verified before entry into the system.

2. Most schedules and reminders are to be kept under computer clock control and printed automatically.

3. All areas of the hospital will have immediate access to records of patients who have been admitted, discharged, or transferred. Location records will be maintained on all in-patients.

4. All messages will be printed in prose form for easy understanding.

5. All conflicts in patients' schedules will be printed in the appropriate area as soon as service is requested.

6. Inventory for all hospital items will be maintained.

7. Pricing, except in exceptional cases, will be automatic.

Admitting

1. Bed availability lists can be obtained as required.

2. Affected areas will be automatically notified of admissions, transfers, newborn, and discharges.

3. Census, summary, and statistical reports will be automatically compiled.

Blood Bank

1. Blood inventory, showing expiration dates and units assigned, but not administered, will be instantly available and automatically updated.

2. All operations scheduled will include estimated blood usage. This schedule will be flashed to the blood bank to gauge requirements.

3. The quantity of blood used and expired and other statistical data will be maintained by the system.

Business Office

1. In-patient billing will be a by-product of direct patient care.

2. The complete bill will be ready at the moment of discharge.

3. Up-to-date billing will be available any time during the patient's stay. All bills will be itemized.

Central Supply

1. Inventory will be maintained by the computer. Usage statistics, re-order points and order quantities will be produced.

2. When medication trays are prepared, inventory will be updated accordingly. Variances from standard tray makeup will be recorded.

3. Daily usage of central supply items in service areas and nurses stations will be printed each day for refilling.

Dietary

1. Individual menu selection, house and special diets combined by the system will produce food calculations.

2. Menu planning, with computer assistance, will be available to all hospitals in the group.

3. The system will print the routing and tray assembly list, adjusting for holds or changes of orders. Inconvenience and food wastage are reduced by noting deletions, corrections, and additions immediately.

Doctors

1. Doctors will be able to enter their orders directly into the system. The printed output will be signed by the doctor and placed in the patient's chart by the nurse. This will eliminate the doctor's writing orders in longhand and insure that his instructions reach the service area exactly as ordered.

2. Patient profiles will be available for:

Medication ordered and administered.
Laboratory results and outstanding orders.
Blood requirements and usage.
Radiology results and outstanding orders.
Physical therapy notes and outstanding orders.
Electrodiagnostic results and outstanding orders.
Nursing instructions.
Nurses' notes and vital signs.

3. Patient schedules and previous admission histories will be quickly available.

4. Toxic dosages for medications will be indicated on orders.

Electrocardiography

1. Medication which could affect tests will be listed on request for ECG.

2. Condensed test results will be sent to nurses' stations as soon as tests are complete.

Laboratory

1. Accuracy will be insured through automatic preparation of specimen collection schedules, reminders, lab work schedules, and test requisitions.

2. Programmed special instructions for collection and routines will be printed on schedules.

3. Medications which could affect tests are listed on the request and technician work lists.

4. A daily summary of test results by patient will be prepared by the system from stored test results.

Medical Records

1. A summary discharge report will contain important aspects of the patient treatment, providing significant background for future medical care.

2. Statistics and facilities utilization data required for accreditation and reports will be automatically compiled.

Nurse Stations

1. Nurses will have the ability to order drugs from either the pharmacy or from ward stock with automatic updating of inventory.

2. Hourly medication schedules will be printed under clock control or by request. Positive verification of medications given is required.

3. Specimens for laboratory tests which nurses collect will be printed under clock control or by request. The collection schedule will contain any special routines or collection instructions.

4. A summary of laboratory tests by patient will be available by request.

5. The patient's schedule will be maintained by the system. When a request for service is made which causes the patient to leave his room, the schedule will reflect any conflicts.

6. Dietary hold orders resulting from service requests will be generated automatically.

7. Condensed test results for radiology, physical therapy, and electrodiagnostics will be routed directly to the nurse station after completion of the test.

Operating Room

1. Surgery schedules will be kept within the system for immediate referral. The schedule will include the estimated blood requirements and whether or not a pathologist is required. Operating room data is available to the laboratory and blood bank.

2. Standard and customized pre-operation routines will be printed at the areas affected.

3. Immediate adjustments for delays or sudden cancellations will be made by notifying the patient areas concerned. This will prevent patient queueing and improve the utilization of the operating room.

4. Charges for the operating room, drugs, central supply items, and the like, will be entered immediately after the operation.

Pharmacy

1. Prescriptions will be transmitted immediately to the pharmacy, providing a printed record of the verified order, eliminating manual transcription and reducing errors.

2. The stored pharmacy index will contain current statistical and cost information for drug stock.

3. Use of economical purchase order quantities and minimum quantities will provide positive re-ordering and stock adjustment.

4. Ward drug stock usage will be printed and refilled daily, eliminating many emergency trips to the pharmacy.

Physical Therapy

1. Progress reports will be sent to the proper nurse station as soon as the procedure is completed.

2. Pricing and utilization statics will be maintained.

3. Diet hold orders will be handled automatically where applicable.

Radiology

1. Diet hold orders, transportation requests and other routine instructions for each type of examination requested will be performed by the system.

2. Condensed test results will be sent immediately to the proper nurse station as soon as the test is completed.

3. Pricing, film usage, and inventory will be maintained.

Integrated Information System

United Air Lines
New York, New York 10017

United Air Lines announced in December 1965 that it has commissioned UNIVAC Division of Sperry Rand Corporation to design and build for the airline an on-line computerized information system, representing an investment of $56 million, the largest in the business world and the first to utilize cathode ray tube input-output devices on a nationwide basis.

George E. Keck, United's president, announced that the information system will provide United with a nationwide, totally-integrated reservations, operations, and management data processing system.

The $56 million investment covers the $39 million cost of the basic electronic equipment and computers and $17 million for leased transmission lines for a 5 year period and new facilities required for installation of the system.

Contracts signed with the Sperry Rand Corporation call for delivery of equipment beginning in 1967 and for the system to "go on the air" early in 1968. It will be designed to handle United passenger and fleet operation volumes through 1975, Keck said.

Built around a centralized computer complex using three large scale integrated UNIVAC 1108 II computers with nearly 1 billion characters of random access storage, the electronic information system will at first require only a limited portion of the capacity of each of the computers and offers the airline at least 100 percent expansion capacity in line with United's projected passenger traffic growth which is expected to double in 5 years.

A unique capability built into the agent sets to be employed at United ticket counters and air freight terminals will be automatic ticket or airbill printing. By merely actuating a button, the passenger or freight agent can issue a ticket or airbill in seconds.

Current plans call for the computer installation to be located at United's executive headquarters near Chicago and will require construction of a new two story structure costing

approximately $5 million. Initially, the system will utilize a major part of the first floor of the planned structure.

The new system, which will link all 116 United cities throughout its 18,000-mile route structure, will replace the airline's present "Instamatic" reservations system.

Development of the System represents more than 3 years of planning by United and will require the equivalent of 200 man years of system analysis and programming effort before it becomes operational.

Information processed by the new system will initially cover 17 basic information categories including applications ranging from passenger reservations, complete name record storage, crew and aircraft scheduling, flight planning, and meal planning data, to air freight and cargo loading information.

The vast capacity of the system includes the ability to handle more than 140,000 transactions per hour involving transmission of 35 million characters with a response time of 1 second per individual transaction.

Cathode ray readout screens on agent sets at airport terminals, ticket offices, reservation and freight offices, as well as United's headquarters, are capable of instant display of over 1000 alphanumeric characters.

Say an agent asks the system for space on a 3 p.m. flight from San Francisco or Chicago. By merely querying his set, the agent will get a readout on the screen showing seat availability for the requested flight. The computer will also automatically display availability on up to 10 other flights between the cities involved... all within seconds.

Similarly, information on total passenger loads, flight information, weather, cargo, or freight loads can be displayed on the cathode ray tubes on demand. Each set will contain a console including a complete typewriter keyboard, plus more than 40 selective function keys on which to communicate with the computer.

In actuality, the computer system is operating at speeds approaching the speed of light with electronic impulses being transmitted in millionths of a second to interrogate data already in storage in the computer and return its findings to the cathode ray readout sets or to paper-copy printers linked with the sets.

The system will also provide United management with basic data vital to operating a jet fleet of 309 aircraft and a passenger volume expected to reach 30 million passengers annually by 1970.

The information system will operate over more than 100,000 miles of high speed leased data transmission lines and circuits of the American Telephone and Telegraph Company. As a safeguard to continuous operation on a 24-hour, 365-day basis, United will employ two alternate commercial power sources, as well as auxiliary emergency backup systems employing diesel-powered generating equipment.

Because the system will amass information on aircraft by actual number of the plane and its accumulated time in flight, the computer will automatically schedule planes for on-line maintenance checks as well as major overhaul at United's maintenance base in San Francisco. It will do the same for aircraft parts stored at system-wide line maintenance stations and for those required at the maintenance base to maintain total inventory records.

All flight crew data for pilots and stewardesses will be stored in the rapid access system memory so that the airline will be able to assess crew member availability rapidly on the basis of hours flown, as well as on the basis of assignment by aircraft, airport, and route.

The system will be built by Sperry Rand at its UNIVAC plant in St. Paul, Minnesota. The system involves the highest level of the state of the art of electronic data processing technology and will ultimately take over other functions such as electronic message switching and automatic flight monitoring.

Data Processing Division
U.S. Navy Electronics Laboratory
San Diego 52, California

NEW DIGITAL PROCESSING COMPLEX

Installation of the major components of a Program Generation Center at the U.S. Navy Electronics Laboratory, San Diego, California, has been completed during the past 6 months. The function of this complex is to prepare programs for the operational test and evaluation of various naval tactical and strategic systems and/or components involving digital processors.

To perform this function, the militarized UNIVAC CP-667 has been installed. It is equipped with an on-line card reader, an operating console, 11 magnetic tape transports, a random access disc memory, and a high-speed paper tape unit. The Center is operated in the off-line mode using a CDC 8090 computer for Input/Output processing.

The CP-667 computer has a 2-microsecond basic cycle time with 130,816 words of 2-microsecond memory. For scratch memory and control registers 256 words of 400 nanosecond memory are provided. The basic word length is 36 bits, but the machine is equipped with a 30-bit option. In the 30-bit mode, memory is reduced to 32,768 words which contain the 256 words of 400-nanosecond control memory. The CP-667 has 16 input/output channels with extensive interrupt circuitry, and has an instruction repertoire including all typical operators plus hardware floating point and double precision instructions.

The Program Generation Center is operated and maintained by the Data Processing Division (NEL Code 3390) for the support of Laboratory projects in the area of navy tactical and/or strategic data processing. During the past 6 months the system has been used primarily for prototype equipment checkout and software system development. Currently operating are the CS-3 compiling system (36 bits) and NELOS/NELIAC operating system (30 bit). Under development are a JOVIAL compiler and a CS-1 compiler (30 bit).

Reliability of the equipment has increased through installation phase to an average of 92-percent uptime over the past 2 months including preventative maintenance. The average weekly processing load has been 52 hours per week for that same period.

Self-instructional Manual for the CP-667

The Data Processing Division has developed an easy to master, step-by-step, self-instructional manual to teach programming on the UNIVAC CP-667. The primary objective of this manual is to train programmers to use the CP-667 in an efficient manner by preparing, compiling, and debugging their own programs and by operating these programs on the computer. Completion of this manual will not qualify the student as an expert programmer. Only time as a practicing programmer can accomplish that purpose, but the book will teach the student the basic tools of programming and the fundamentals of programming for the CP-667.

The manual itself, although it follows the general precepts of automated instruction, is not set up in the usual programmed text format. The major deviation between this and other programmed texts is in the size of the "frames" used. Developing a programmed text with many hundreds of tiny "frames" gives the student a feeling that a teaching program has been developed for a piece of hardware, but with the hardware missing. There is no question that this method works, but for computer programming, a great many examples, and examples in great detail are required. Therefore, the text was set up to impart a small amount of information followed by extensive examples and problems. The correct answers are always furnished on the following page with additional comments and references as required.

The approach used has the following objectives:

1. To eliminate formal training courses and instructors.

2. To allow students to proceed at their own pace.

3. To require no previous training or experience.

4. To permit experienced trainees to skip basics.

5. To eliminate unproductive waiting time between course schedules.

6. To keep failure to a minimum.

7. To provide a means of early qualification of trainees.

8. To be inexpensive.

Each "frame" is a lesson covering an idea or concept susceptible to concise treatment. The lessons are grouped into logical "families" or concepts, called units. Each unit is concluded with a unit quiz which recapitulates the material already covered.

This technique has been used for several years at many universities and industrial plants to train computer programmers on similar hardware and also on software (IBM 1401, IBM 7090, COBOL, etc.). It has been found to be an effective teaching method and studies of the effectiveness of the method indicated that trainees were being turned out faster, better trained, and with fewer failures.

CHANGES IN EXISTING GENERAL PURPOSE COMPUTER CENTER AT NEL

The NEL Computer Center, used for general scientific oriented problem solving and management data processing, has been relocated and enlarged. The existing CDC 1604B/160A complex has been installed in a new facility housing all card support service equipment. Additional tape transports have been added to provide a total of 10 available on two I/O channels.

Modifications in the NELIAC systems, addition of COOP Monitor (FORTRAN, COBOL & SORT) and JOVIAL systems combined with off line operation and equipment additions have provided increased efficiency. The average processing hours achieved per day has been 16.7 hours on the 1604B. Average throughput has been reduced to 4.1 hours.

PERT TIME/COST IN COBOL

A PERT system in COBOL is being developed at the U.S. Navy Electronics Laboratory, San Diego, California. The main objective of this system is to make it easy to use and as machine independent as possible; this would allow the user to keep the same PERT system even if computers were changed. Input editing and error detecting will be performed prior to the processing, and record formats will be compatible with various manufacturer's hardware.

The approach taken was that of a subnetwork with a planned capacity of 3000 activities per subnet. This will eliminate forced creation of illogical subnets and consequent interface difficulties when setting up or amending large networks. A capacity of more than 3000 skeleton activities per network will exceed similar capacities of other PERT systems and allow a variable but high maximum number of subnets to be interfaced for any network. Standard PERT/TIME reports will be provided, with options for the following features: omission of completed activities; computation of expected and latest allowed start dates; expected end data computation which does not assume that an activity is started immediately when prior activities are completed, i.e., a method to delay activity starts.

Cost reports will meet DOD-NASA tabular reports requirements. Three kinds of overhead computations will be handled: regular per hour (e.g., labor), regular per dollar (e.g., material) and compounded per dollar (e.g., General and Administrative, where base includes previously computed overhead costs). Input balancing procedures and change reports will be provided. Costs for one specific fiscal year only may optionally be extracted and reported. Also optional is the display and identification of future costs already committed.

Digital Computer Power Control

West Penn Power Company
Greensburg, Pennsylvania 15601

A new and advanced all-digital control computer system for economic power dispatching and generation control will be placed in service in early 1967 by Allegheny Power System.

Allegheny Power System includes West Penn Power Company (Greensburg, Pa.), Monongahela Power Company (Fairmont, W.Va.) and Potomac Edison Company (Hagerstown, Md.), and serves about 825,000 customers in a 29,600-square mile area in parts of five states – Pennsylvania, Maryland, West Virginia, Virginia, and a small portion of Ohio.

The system presently includes 14 steam power stations and 1 major hydroelectric station with a total of 40 major generating units available for operation. These units have a combined generating capacity of 2,643,000 kilowatts.

The new IBM 1800 computer will replace the analog computer and control equipment at the System Operations headquarters at Charleroi, Pa. The present analog computer at Charleroi, when installed in 1957, was the first of its kind used in the many economic calculations involved in power dispatching.

Through a communications network, the new control computer system will be linked with the 15 system generating plants and 22 interconnections with nonaffiliated companies. It will automatically control the output of the generating units throughout the five-state area. The computer will also consider transmission losses, fuel costs, incremental heat rates, tie-line flows, maintenance costs, and other pertinent factors.

Fully automatic control is essential to supplying power efficiently and reliably in the face of constant fluctuations in demand. In addition to an automatically dispatching generation from minute to minute, the new computer will schedule the most economical combinations of generators to operate in supplying customer needs around the clock.

The computer will be used integrate more fully the operations of Allegheny Power System Companies with non-affiliated companies. It will make possible economic benefits to be obtained from balancing the diversity in power needs and peak load timing existing between utilities. By coordinating Allegheny Power System operating facilities with those of other systems, improved reliability, and economy of service over a widespread area will result.

The all-digital control equipment will also continuously monitor and record the day-to-day operations that are performed. Such data will be used to produce essential reports and background information for West Penn and its Allegheny Power System affiliates.